Translation of DE 949 899

Axial fan or axial pump having pivotabl rotating blades

As is known, axial fans and axial pumps having pivotable rotating blades have an extensive capacity to be adapted to various operating states. However, hitherto certain difficulties have arisen in the case of machines which have a large pressure number and, on the one hand, a large blade depth (axial extent of the blade) in comparison with the blade length (radial extent of the blade) and, on the other hand, a very small radial gap between the blades and the housing; in designs where a high degree of efficiency is required, this gap is only approximately from 1 to 2 % of the blade length.

Under such circumstances, in order for the blades to be freely pivotable, both the inner and the outer periphery of the blades and the outer wall of the hub and the inner wall of the housing have to be spherically curved concentrically with respect to one another in the area in question. Then, however, in the case of the conventional arrangement with rotating blade pivot axes perpendicular to the axis of rotation

of the impeller, in order to be able to install and remove the rotor it is necessary to provide for a divided design of the housing with comparatively great expenditure, in terms of materials and work, on production, mounting and sealing, or it is necessary to provide for special mounting slits in the housing. Although it is possible to avoid this disadvantage if the inner wall of the housing is in a form such that it is cylindrical throughout, in accordance with the construction with fixed blades, there is nevertheless a larger gap at the inlet and outlet end of the blades with a correspondingly greater loss of efficiency.

A further disadvantage of the spherical inner and outer boundary of the blades and of the corresponding construction of the outer wall of the hub and the inner wall of the housing in the case of radially directed blade pivot axes is that the outer streamlines in the second half of the axial blade depth extend inwards. As a result, the flow medium is imparted a speed component opposing the centrifugal force and this leads to difficulties known per se in the boundary layer, especially at the hub, and at least some of the gain obtained by the reduced gap leakage is lost again.

In order to overcom th above-mentioned deficiencies, the problem of a suitable construction for axial fans or axial pumps having pivotable rotating blades, in th case of which the inner and outer blade end faces, the hub outer wall side and the housing inner wall side form concentric partial spherical faces, is solved in accordance with the invention in that the pivot axis of each rotating blade, passing through the mid-point of the sphere, forms, with the axis of rotation of the impeller, an acute angle which is open in the direction towards the impeller inlet and which is of a size such that, in a blade position intended for the axial installation or removal of the impeller, the largest blade circle is smaller then the smallest diameter of the inner wall of the housing.

In this connection, in order to minimise the bending stress in the blade, it is also advantageous if the centre-of-gravity line connecting the centres of gravity of the various blade cross-sections forms, with the pivot axis of the blade, an angle such that it stands at least approximately perpendicularly on the axis of rotation of the impeller in the region of the operating positions mainly concerned.

A construction which contains the above features of the invention and the further details of which can be found in the following description achieves the great advantage that, even in the case of pivotably arranged blades having a large axial depth, on the one hand, and a small radial gap, on the other hand, the undivided design of the housing can be retained without having to contend with an increased risk of the boundary layer flow separating as a result of inwardly directed streamlines. Rather, without special construction, it is possible to keep the gap equally small for all blade positions and over the entire blade depth and, by a suitable inclination of the pivot axis of each blade relative to the axis of rotation of the impeller, to bring about a desired minimum inclination of the streamlines outwards. As a result, the degree of efficiency in the case of partial loads is improved.

The subject-matter of the invention is shown by way of example in an embodiment in the drawing.

Figure 1 shows an axial fan with opened impeller blades (operating position) in a partial axial section;

Figure 2 is a corresponding view of the same fan with almost closed impeller blades (throttle or rest position);

Figure 3 shows two cross-sections through a rotating blade at the hub and at the circumference in the opened blade position;

Figure 4 shows two corresponding blade cross-sections in a greatly throttled blade position; and

Figure 5 is an enlarged cut-out portion of Figure 1 with the mounting position of an impeller blade indicated.

In the undivided housing 1 of an axial fan, the impeller blades 2 are inserted pivotably by their foot 3 into a semi-spherical portion of the hub 5 arranged on the shaft 4, while the following guide blades 6 and their inner boundary ring 7, which extend, except for the gap distance, as far as the impeller hub, are produced in one piece with the housing. The inner and the outer limitation of the rotating blades are spherically curved and extend, with a small gap distance which is equal throughout, concentrically to the correspondingly constructed faces of the outer

side of the hub and the inner side of the housing; accordingly, these blades, with th radial gaps remaining th same, can be pivoted through 360°. The pivot axis 8 of each impeller blade forms with the shaft 4, that is to say with the axis of rotation of the impeller, an acute angle α, which is open towards the impeller inlet, and extends through the common centre of curvature of the faces, constructed as portions of a sphere, of the rotating blades, the impeller hub and the housing.

The inlet edge 9 of the rotating blades extends in such a manner that the projection of its outermost point in axial section, in the case of a completely opened blade position (Figures 1 and 5), lies exactly on the pivot axis 8 and in the case of a mounting position pivoted through approximately 180° with respect thereto (shown with a broken line in Figure 3) it is spaced slightly away from the pivot axis 8 on the inlet side. Because the smallest diameter of the inner face of the housing lies slightly further outwards on the inclined blade pivot axis, that is to say, it forms a larger circle than the circle passing through the outermost points of the individual blades in the case of the last-mentioned blade position, the entire impeller can then be readily installed and removed in the axial direction.

By using a slightly different construction of th blad s or by reducing the angle of inclination of the pivot axis 8, it is even possible to arrang the outermost blade points, in the case of a specific blade position, at a sufficiently great distance from the inner wall of the housing to enable the individual blades to be installed and removed without axial displacement of the hub.

The centre-of-gravity line 10 formed by the centres of gravity of the various blade cross-sections intersects the pivot axis 8 advantageously approximately at the transition from the blade bowl to the blade foot 3 at an angle γ such that it extends at least approximately perpendicularly to the axis of rotation of the impeller in the region of the blade operating positions mainly concerned. As a result, the blade bending stresses caused by the centrifugal forces are minimised.

CLAIMS

1. Axial fan or axial pump having pivotable rotating blades, wherein the inner and outer blade end faces, the outer wall of the hub and the inner wall of the housing form concentric partial spherical faces, characterised in that the pivot axis (8) of each rotating blade (2), passing through the mid-point of the sphere, forms with the axis of rotation (4) of the impeller an acute angle (α) which is open towards the impeller inlet and which is of a size such that, in a position of the blades intended for the axial installation or removal of the impeller, the greatest blade circle is smaller than the smallest diameter of the inner wall of the housing.

2. Axial fan or axial pump according to Claim 1, characterised in that the inlet edge (9) of each rotating blade (2) lies with the projection of its outermost point approximately on the pivot axis (8) when the blade is in the open position in axial section.

3. Axial fan or axial pump according to Claim 1, characterised in that the pivot axis (8) of each rotating blade (2) intersects the inner

wall of the housing approximately at the narrowest point.

4. Axial fan or axial pump according to Claim 1, characterised in that the centre-of-gravity line (10) formed by the centres of gravity of the various cross-sections of each rotating blade (2) extends at such an angle (γ) relative to the pivot axis (8) that it stands at least approximately perpendicularly on the axis of rotation (4) of the impeller in the region of the blade operating positions mainly concerned.